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NOTES ON PRESERVATION OF RECORDS

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PREFACE.

At the Baroda session of the Indian Historical Records Commission the comparative merits of the new method of laminating old records with cellulose acetate foil and mending crumbling papers with thin silk gauze commonly known as chiffon were discussed in some details. Sir Jadunath Sarkar, the seniormost member, who occupied the chair in the unavoidable absence of the Hon'ble Sir Girja Shankar Bajpai thought that the Commission was not competent to pass any opinion on so highly technical a subject on which American and English opinion was sharply divided and suggested that the brief note prepared by the Imperial Record Department should be circulated among the Provincial Governments with Dr. Baliga's criticisms and such comments as the Imperial Record Department had to offer in reply. It was further decided that a note prepared by Mr. K. Sitarama Iyer of Travancore on a Sulph-Arsenical insecticide should also be circulated for the information of the Archivists interested in the subject. It is in pursuance of that suggestion that this pamphlet has been prepared and the comments and criticism embodied in it may, it is hoped, be of some use to the archivists and librarians in India.

S. N. SEN,
Keeper of the Records of the Government of India.

IMPERIAL RECORD DEPARTMENT,
NEW DELHI,
The 20th August 1941.

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Relevant extracts from the proceedings of the Indian Historical Records Commission relating to the Best Method of Preservation of Records. (Pages 5-6 of Part III, Volume XVII.)

Preservation of old records is one of the problems which has been engaging the attention of the Imperial Record Department for some time past. In the absence of any scope for conducting researches on the subject the department sought the advice of several learned institutions in India and the Record offices of England and U. S. A., where extensive investigations have been made about all the cognate problems. It appears that deterioration of paper is caused by—

(1) Chemical changes brought about by moisture and atmospheric gases,

(2) Acid fumes condensing on dust particles,

(3) Ordinary wear and tear,

and the ideal process of repair should be one which takes all these factors into account and adds to the strength of the paper and retard the process of deterioration due to (1) and (2).

It has been found that the reinforcing of brittle records with chiffon or Japanese tissue paper now in vogue in this country does not entirely serve this purpose. The National Archives of U. S. A. concluded after a thorough investigation that cellulose acetate foil, if laminated by a hydraulic press, adds most to the life and strength of old papers. This method entirely eliminates the need of adhesives and adequately protects the paper so treated from the harmful effects of atmospheric gas and rough handling.

Another serious problem that confronts an archivist is that of preventing the ravages of insect pests. Constant warfare has to be waged against their inroads. The cellulose in paper and fabric attracts some species of voracious insects and others are particularly fond of such book components as glue, starch, etc. Laborious researches conducted in U. S. A. have now satisfactorily established that the most effective way to combat these pests is to fumigate the papers affected in a vacuum vault. Manuscripts have to be placed in a gas-tight steel chamber where a large proportion of the air has to be removed and replaced with a gas lethal to insects. The fumigant penetrates into pores and interstices and kills the insects as well as their larvæ within a short time. Bundles containing records need not be opened when they are placed in the vacuum chamber, as they have to be during ordinary fumigation.

A hydraulic press of the type required for the purpose of lamination can be obtained from Messrs. R. D. Wood Company, Philadelphia, P.A., at a cost of $7,555 or Rs. 26,000 including freight charges. The operating cost of this machine and the recurring expenditure on cellulose products is said to be very small. Compared to Japanese tissue paper and chiffon, cellulose acetate foil is very cheap. Cellulose acetate foil measuring 30″ × 40″ costs Rs. 35 per ream,

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or annas 12 per 100 square feet. Chiffon (' lisse ' quality 383|368) 40" wide costs about 2*s.* 1*d.* a yard, *i.e.*, about Rs. 14 per 100 square feet. The price of Japanese tissue (Tosa B or Mino AA) is about $4·50 per ream. While Japanese tissue paper costs 5 to 6 times more than cellulose acetate foil, chiffon costs 5 times as much as Japanese tissue. With the introduction of the hydraulic press and cellulose acetate foil, the general outturn of laminated sheets will greatly increase, resulting in actual saving in the near future, so that the initial expenditure of Rs. 26,000 is perfectly justified.

A fumigation chamber ($4\frac{1}{2}' \times 5\frac{1}{2}' \times 11'$) suitable for the vacuum fumigation of records can be obtained from the Guardite Corporation, Chicago, Illinois, at a cost of $3,600, *i.e.*, Rs. 13,000 including freight charges. The operation of the chamber is easy and inexpensive though this must be done under expert supervision.

It seems desirable that lamination of records with cellulose acetate foil and vacuum fumigation should be introduced in all organised Record Offices in India.

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Note Recorded by Dr. B. S. Baliga, on the Resolution No. IV of the 17th Session of the Commission dealing with " Methods of Preservation of Archives ".

I have to oppose that part of the Resolution which relates to lamination and to suggest a simpler and less costly method of fumigation. Lamination, so far as I know, has been recommended only by the National Archives of America. In the second annual report of the Archivist of the United States (1935-36) it is stated that in the process of lamination—which, of course, the American Archivists regard as superior to the method of mending with chiffon, for the reasons stated in the Resolution—the document is placed between two sheets of very thin cellulose acetate foil, which being thermoplastic, adheres to the paper upon the application of heat and pressure. The report goes on to say that " documents so treated are practically impervious to gases, and if necessary, may be cleaned with soap and water. Tests of the permanence of treated records indicate that they will be relatively unaffected by the normal process of deterioration " (*vide* pp. 42-43). In the third report (1936-37) it is pointed out that lamination can only be done under expert supervision, " under the supervision of some one equipped with the requisite technical knowledge of the composition of paper, inks, gases, and repair materials, and of the application of moisture, heat and pressure upon different kinds of paper and ink " (*vide* pp. 12-13).

I submit that this technical method, this work of experts, is a thing of very recent growth, the future behaviour of which cannot be predicted with any degree of certainty. The " National Archives of the United States " was only established in 1934. (The Act establishing it was passed on 19th June 1934). The first lineaments of the lamination process, which was introduced into these archives, we begin to observe only in 1935-36. Five years is indeed too short a period to enable us to garner any results of practical experience.

Both British archive practice and British archive theory are opposed to all new chemical processes which cannot be said to have stood the test of time. It can be safely asserted that, in the matter of archive preservation, they eschew all " innovation " or " laboratory test ". Mr. Hillary Jenkinson, the present Secretary of the Public Record Office, London, who, until recently was in charge of the Repairing Department of that office, and who besides being the author of the well-known book " Archive Administration ", is also the Secretary of the Technical Section of the British Records Association, gives us an emphatic warning " against the employment of any trade preparation of unknown composition or any other scientific short cuts " (British Records Association Progs. No. 1, p. 11). " No laboratory test " he says " can tell us what the effect of time will be on materials " (*Idem*) and the " unique character of archives makes it unjust for anything in the nature of experiment in regard to them except where all known methods have failed to arrest decay " (Archive Administration, 2nd Edition, p. 69). It is signified that in his enlarged and revised edition of ' Archive Administration ', published in 1937, he ignores the lamination process altogether and recommends the use of pure silk Gauze (*Idem*, p. 70), or, as we call it, chiffon, for protecting and strengthening old and fragile documents.

Turning to the particular qualities of celluloid preparations, of which cellulose acetate foil is one, the general opinion of the Technical Section of the British Records Association is that such preparations are definitely harmful to

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the documents. In the first bulletin of the Technical Section, Mr. Hilary Jenkinson, in reply to a question, states that " it is dangerous " to use dissolved celluloid for strengthening delicate paper or paper which has been weakened by damp (*vide* p. 2). Mr. G. Herbert Fowler, the Chairman of this Technical Section an eminent authority on archives, the author of the " Care of County Muniments " and Chairman of the Bedfordshire County Records Committee, proceeds a step further and declares that " ordinary celluloid, a solution of which has largely been used on documents, is believed to have a comparatively short life " and that " on decomposition it may yield a nitrous acid vapour which would be by no means inert towards either ink or parchment ". He adds that " nothing which is charged, even to a slight degree, with any of the active inorganic acids, sulphuric, nitric or hydrochloric, and may give off an acid vapour should be permanently in contact with a document ". The moral he draws is " that we should use only such materials and methods as have stood the test of time in other employment " (*vide* Archive Administration, 2nd Ed., p. 3).

In the third bulletin for September 1938, Mr. G. S. Heaven, the Managing Director of the British Cellophane Limited, Somerset, England, observes that " it is a very unsafe thing to use any modern plastic material for attachment to ancient documents " and he includes cellulose acetate among such plastics. In this connection he refers to certain points which at once make us think whether lamination might not prove positively harmful and dangerous to the documents in course of time. He remarks as follows : " On the assumption that no plastic material can adequately protect the document unless there is adhesion, then the question of temporary and permanent relative expansion arises ..... the fibrous paper and the non-fibrous colloid will behave so differently as to endanger the document to be protected ". There is no modern plastic, including cellulose acetate, he says, " which could be guaranteed as safe, as even if they are non-hygroscopic, shrinkages or expansions must be developed " (*vide* pp. 5-6). There can be no doubt therefore that if these expansions and shrinkages of the cellulose acetate foil are to take place, the document protected would, in course of time, get totally mutilated.

Finally we have the considered opinion of the whole Technical Section of the British Records Association, pronounced so recently as October 1939 (please see Bulletin 7), that lamination is unsuitable to the records. On examining a sample of a sheet of paper subjected to the process of lamination adopted in repairing the records of the United States of America, they expressed the opinion " that adoption of the process would not be suitable in this country (England) especially where parchment, rag papers and papers of similar fibrous bases are in question " (*vide* p. 1). And as the paper used in India, under the East India Company's administration, was largely imported from England, I have no doubt that they would have regarded lamination quite as unsuitable for our early records. My submission, therefore, is that in view of the novelty of the experiment which cannot be said to have stood the test of time, in view of the repeated warnings given by eminent archivists in Great Britain not to resort to any chemical methods for the preservation of archives, save those that have been found successful by experience, and in view of the harmful effects of all celluloid preparations, including celluloid acetate foil, which have been pointed out, we are not justified in recommending the substitution of lamination to chiffoning in all recognised archives in India.

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As to the second part of the resolution, which relates to vacuum fumigation, another American archive method, I have no objection to offer. It would be a good thing indeed if the Government could spend, as it suggested, Rs. 13,000 at the outset in procuring the fumigation chamber. But, of course, each local government will have to decide whether it has under its custody such a considerable quantity of moth-eaten and moth-infested records, as would demand the expenditure involved in purchasing the chamber. So far as the Madras Record Office is concerned, almost all volumes of the old records upto 1800 have been repaired, reconditioned with chiffon and rebound into handsome volumes. Since reconditioning has been done with a special paste* containing a percentage of arsenic, a substance which gives a sufficient protection against the ravages of insects and borers, these reconditioned records require no fumigation. The process of reconditioning the Company's records subsequent to 1800 and other miscellaneous records is now carried on under a definite programme. A portion of the old Collectorate records, which have been transferred to this office, has also been repaired. Only some minor series of records, therefore, which show signs of ravages of borers, have to be fumigated. The question, therefore, is, whether, instead of obtaining the costly fumigation chamber, we may not adopt some simpler, less costly, and, perhaps, as effective a method of fumigation. Such a method, I suggest, is possible, and has been recommended by Mr. Jenkinson in his book 'Archive Administration' (Second Edition).

This is what he observes. "In his choice of methods for dealing with the pests when precautions for their exclusion have proved inadequate, the Archivist is limited by the nature of his materials; he obviously cannot use heat nor, in general, a liquid application. Remain the possibilities of vaporization and various materials have been suggested. In regard to these it must be clearly stated that we have at present (at most) only laboratory tests to assure us that they will have no undesirable result at some future date on the materials exposed to them. With this reservation English opinion is at present recommending the use of paradichlorbenzene crystals, in the proportion of one pound per ten cubic feet. The crystals may be laid at the bottom of a large box and the volumes, etc., placed on grating above them; the box is then kept closed (all joints being carefully sealed with vaseline or some other luting) for not less than 10 days.

"This treatment can be used also to deal with larvæ of moths, whose ravages especially on leather are not perhaps of frequent occurrence but are particularly frightening when they do happen" (Archive Administration, 2nd Edn., p. 221). This method, in my opinion, can be tried where documents to be fumigated are not very numerous.

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*Formula.

Dextrine	5 lbs.
Oil of Cloves	1½ oz.
Saffrol	1½ oz.
White arsenic	2½ oz.
Water	10 lbs.

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Note on the utility of Lamination and Fumigation as methods of preserving records, by Dr. S. N. Sen, M.A., Ph.D., B.Litt. (Oxon), Keeper of the Records of the Government of India.

Before discussing the criticism of Dr. Baliga I must express my obligations to him for the care with which he examined my note. It is only by constant examination and re-examination of scientific theories and authenticated facts that we can expect to arrive at the right solution of our problems. We should not forget that no method of preservation in vogue at present is absolutely perfect and science has not yet been able to devise so far any means of safeguarding manuscripts from natural deterioration and decay for all time to come. But that does not mean that we should refrain from fresh experiments though every care should be taken not to expose any record to unnecessary risk. Without experiments progress is not possible and the archivist who first used chiffon for strengthening his records deliberately made an important experiment. We must be guided by reason, and blind faith in sweeping generalisations even when they come from a leading authority cannot but lead to stagnation.

Lamination.

The process of lamination consists essentially, of heating cellulose acetate foil to a plastic state and pressing it into the pores of paper, thus forming a homogeneous unit when cooled. A document to be repaired is placed between two slightly larger sheets of thin cellulose acetate foil, which, being thermoplastic adheres firmly to the paper upon the application of heat and pressure in a hydraulic press.

Dr. Baliga is not in favour of lamination process mainly because ' it is a thing of recent growth, the future behaviour of which, cannot be predicted with any degree of certainty '. He does not therefore prefer cellulose acetate foil to chiffon. Let us examine his arguments in the light of recent experience.

1. As a protective coating, chiffon has been in use in the Imperial Record Department since 1914 and the experience so far gained does not preclude the necessity of better repairing materials. Our conclusion is also corroborated by the National Archives as will be seen from pages 42-3 of the second Annual report of the Archivist, 1935-36. It is stated " All the procedures commonly used for this purpose (repairing) involve the manual application of an aqueous adhesive and coarsely woven silk fabric (chiffon). This treatment increases the durability (resistance to the wear and tear of handling) of the document but does not improve its permanence qualities (resistance to other deteriorating influences such as light, heat and acidic gases). Moreover, the operations involved are tedious and delicate and require skill obtainable only by long training. The ideal repair process is one in which the document is sealed permanently against the harmful gases of the atmosphere, in which no adhesive is necessary, and which may be applied rapidly and easily by workers of average intelligence and ability ".

(ii) Surveys made in the National Archives having shown that many of the records are in poor condition, an investigation of the various methods of repairing and re-inforcing documents and manuscripts was made. The result of the investigation has since been published in the form of a report by the National Bureau of Standards. Section IX of the report deals with repairing. As regards chiffoning the report says " Because of the type of adhesive used

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materials so treated may be rendered more susceptible to attack by fungi and insects which prey upon paper " (*vide* page 24 of the report).

(iii) As to Dr. Baliga's objection that lamination has been in use for too brief a period for its future behaviour to be correctly appraised it may be pointed out that science in this respect is not so helpless. An accelerated aging test can easily demonstrate what the ultimate results of the new process will be twenty-five or fifty years hence and although the new method of lamination is admittedly of recent origin the scientists in the Bureau of Standards took the common precaution of subjecting it to the accelerated aging test. If we have to wait for half a century before taking advantage of the recent discoveries of science the deterioration of the papers to be preserved may go too far in the mean time.

(iv) Dr. Baliga seems to think that cellulose acetate foil is a celluloid product. Once there was a tendency to use dissolved cellulose and its compounds, of which celluloid was the most common, for protecting brittle documents either by immersing it in or by spraying it with the solution. It was against this method that Mr. Kimberly, Chief of the Division of Repair and Preservation, National Archives gave a vigorous warning as did the British experts, Messrs. Hilary Jenkinson and G. Herbert Fowler. *Cellulose acetate is different from either celluloid or cellulose xanthate. It contains none of the objectionable inorganic acids* and has actually been found from the aging test to improve the permanence qualities of the documents after lamination. In the light of the result of experiments made by the National Bureau of Standards the remarks of Mr. Hilary Jenkinson, quoted by Dr. Baliga in this connection, are obviously beside the points.

(v) Mr. G. S. Heaven has raised technical issues of real importance when he observes that with adhesion the question of temporary and permanent relative expansion arises. This important question must have been taken into full consideration by the experts at the National Bureau of Standards. The factors which cause such relative variations are : changes of temperature and humidity and chemical changes of the substances. Because cellulose acetate foil is practically non-hygroscopic and because in lamination (as opposed to sizing in which a document is immersed in a plastic solution) greater cohesive forces come into play, relative shrinkages and expansions are minimised. However, it has to be emphasized that such changes occur, more or less, in all archive materials and are responsible for their deterioration. The question thus becomes one of relative advantage. It is now widely recognised that air-conditioning secures the greatest insurance against such changes, and by keeping the documents in an air-conditioned building—and this we have to do for proper preservation—we can, for all practical purposes, do away with the objections raised by Mr. Heaven.

2. Dr. Baliga contends that lamination is not more economical and better than chiffoning under Indian conditions. This statement is also hardly tenable as will be evident from the facts stated below :

(i) A few documents (of which duplicates are available) of the pre-mutiny period belonging to the Imperial Record Department were sent to the National Archives for lamination and report. In returning the documents after lamination the following observation was made :—

" No difficulty was encountered in laminating these papers nor do we believe that the pressure necessary exerts any deleterious effect upon the permanence of the records."

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Mr. Kimberly in a subsequent communication regarding the suitability of Lamination to all-rag papers asserts :—

" It is my understanding that the statement of the Technical Section of the British Records Association to which you refer is founded upon the idea that rag papers and papers of similar fibrous bases possess sufficient permanence in themselves so as to render the use of a preservation process such as lamination unnecessary. *That this is not necessarily so has been repeatedly shown by the work of the National Bureau of Standards on the preservation of records, as well as by our experience with such papers in The National Archives* ".

" The lamination process can be applied satisfactorily to any known type of paper and if properly applied will increase the resistance of that paper to natural aging regardless of the fibrous content of the paper. The National Bureau of Standards has recently conducted an extensive research into the preservation of records by lamination with cellulose acetate sheeting in which specimens of lamination by the process used in The National Archives, as well as specimens laminated by processes involving the use of adhesives, were tested. The test results were eminently satisfactory in so far as the heat and pressure method of lamination is concerned ".

(ii) The Archæological Chemist in India critically examined the method of lamination as well as the documents laminated by the National Archives. He strongly recommended the adoption of lamination in the Imperial Record Department ' in view of the outstanding merits of the method '. He also asserted in this connection that the new process was applicable to all sorts of paper and was not only the best but also the cheapest. Lamination is being done commercially today by the Pyro-glass Company of Neburgh, New York.

(iii) The conclusion of Mr. Kimberly of the National Archives, who has carried out extensive research work on the preservation of records in collaboration with Mr. Scribner of the National Bureau of Standards, is recorded as below :

(a) " Newsprint treated in this manner (laminated) was found to be very stable to the heat test and to the action of light from a carbon arc. Moreover, no impairment of legibility was caused, nor was there an objectionable increase in bulk, as the thickness of newsprint was increased only 0.0005 in. by this treatment.....Other workers engaged in similar researches abroad concur in the findings.

(b) " The so called laminating process, using cellulose acetate foil, yields a product which is *infinitely more satisfactory from the standpoint of increased resistance to deterioration.* Documents laminated with cellulose acetate foil by means of heat and pressure alone, resist the accelerated aging test very well and are very resistant to attack by insects and molds. They retain the flexibility of the untreated paper and are easily legible."

(c) " *Cellulose nitrate sheetings which include celluloid, are relatively unstable* and may have a deteriorative effect on papers brought in contact with them ".

(iv) The comparative advantages and costs of chiffon, Japanese tissue paper and cellulose acetate foil as a repairing material are dealt with in detail below :—

(a) The reinforcing of old and brittle documents with Japanese tissue paper or Chiffon (silk gauze) increases their resistance to handling but does not protect them from general deterioration. The Japanese tissue paper ordinarily available in the market impairs the visibility and the repaired documents quickly turn brown and opaque. Besides chemical action on the paper, the

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adhesive used in fixing them may render the documents more susceptible to attack from insects, fungi and bacteria. The legibility and flexibility may also be affected by treatment with them. Japanese tissue paper is less transparent than Chiffon and, in other respects too, is less suitable at least in Indian climate.

(b) Chiffon is superior to Japanese tissue paper, and therefore, preferable in all respects except cost. It is more transparent, more permanent, easier in application and removal, and more strengthening as a repairing fabric. Chiffon becomes opaque and brittle in about 25 years while Japanese tissue paper may become opaque and brittle in 5 years. The manual application of Japanese tissue paper or Chiffon, in which the operations involved are tedious and delicate, requires skill obtainable by long training. The restoration of opaque documents, previously repaired with Japanese tissue paper, is extremely difficult while chiffon can be removed more neatly in a nice roll whenever required. In the absence of a better and cheaper method, repairing with chiffon is advisable provided an unlimited supply of good quality chiffon is available.

(c) Compared to Japanese tissue paper or chiffon, cellulose acetate foil is the cheapest. Cellulose acetate foil measuring 30 in. × 40 in. costs Rs. 35 per ream, *viz.*, annas 12 per 100 square feet. Chiffon (' Lisse ' quality 383|368) 40 in. wide costs about Rs. 14 per 100 square feet. The price of Japanese tissue (Tosa B or Mino AA) is about $4.50 per ream. Calculated on the basis of pre-war prices, chiffon costs five times higher than Japanese tissue while Japanese tissue costs four times higher than cellulose acetate foil. A team of 24 menders, whose wages amount to Rs. 8,640, are not able to repair more than 50,000 documents per annum. But the cellulose acetate foil can be applied rapidly and easily by workers of average intelligence under proper supervision, and thus the task of treating millions of brittle documents can be simplified, once the optimum pressure and temperature are ascertained. Thus with a six opening hydraulic press the net out-turn per annum will be 3,00,000 sheets, which is six times greater than the manual out-turn of 24 menders. It is needless to say that the cost of manual labour and the repairing materials will be correspondingly reduced.

The facts explained above will, it is believed, justify our recommendation for the adoption of lamination in preference to repair of brittle documents with chiffon.

Fumigation.

Before considering the suitability of vacuum fumigation from the point of view of preservation of records, it seems necessary to describe briefly what vacuum fumigation is and where it differs from ordinary fumigation. In vacuum fumigation commodities are placed in a gas-tight steel chamber, and a large proportion of air is removed and replaced with a gas lethal to insects. It is very effective because the fumigant penetrates into pores and interstices of papers and kills the insects with their larvæ and eggs within a short time. Lack of oxygen renders the insects more susceptible to a lethal gas. The bundles containing brittle records need not be opened, as they have to be for ordinary fumigation. This procedure permits smaller dosages and shorter exposures, a feature which demands special notice where speed is essential. For treating a huge quantity of records infested with insects and fungi, vacuum fumigation is ideal.

2. In addition to reducing the dosage and the length of exposure, this method offers further advantages. At the end of a fumigation the removal of the absorbed and adsorbed fumigants can be speeded up by the process known

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as air-washing, which consists in drawing a high vacuum and breaking it with air. High concentration of absorbed gas, and the consequent inconvenience to the workers while unloading, is thereby avoided. All fumigants are more or less poisonous, but the use of a vacuum fumigatorium makes the detection of any leakage rather easy and as such operators are quite safe. The operation of a vacuum fumigatorium is inexpensive though this must be done under expert supervision.

The fumigant, commercially known as ' Carboxide ' is a mixture of nine parts of carbondioxide and one part of ethylene oxide (C_2H_4O) which has been shown to be harmless to paper, inks and other record components by tests performed at the National Bureau of Standards(1). Carboxide, which is used in concentrations of 30 lb./1000 cu. ft., is sold in 30 and 60 pound cylinders at prices ranging from 14.5 to 16 cents. per pound. Ethylene oxide can be purchased in cylinders containing 75 or 195 pounds @ 42 cents. a pound, f.o.b. the factory.

3. Moth eaten volumes and bundles are spread out on the grating of an air-tight cabinet for fumigation by paradichlorobenzene. The process is quite simple. Paradichlorobenzene crystals are kept at the bottom in a thin layer, 1 lb. being allowed for every 10 cubic ft. Volumes are taken out after 10 days. This method is, however, ineffective at low temperature since insects remain dormant below 60°F. and are little affected by insecticides, and paradichlorobenzene fumes have no effect on the eggs of the insect pests which are generally protected by a hard shell. It is only in Vacuum fumigation that the hard shell of eggs burst under the action of an external vacuum and speedy penetration by a fumigant becomes possible.

4. Coming to the comparative operating cost of vacuum fumigation and *p*-dichlorobenzene fumigation let us consider a chamber 11 ft. by 5½ ft. by 4½ ft. (275 cubic ft.) in either case. ' Carboxide ' will cost about Rs. 20 per 1,000 cu. ft. while *p*-dichlorobenzene of the required purity will cost about Rs. 1-8-0 per lb. (*i.e.*, Rs. 150 per 1,000 cu. ft.). In 10 days fumigation by *p*-dichlorobenzene would mean the treatment of not more than 50 cu. ft. of records at a cost of Rs. 42 for the fumigant (28 lbs.) only. By vacuum fumigation with ' Carboxide ' at least 2,000 cubic ft. of records can be treated in 10 days at a cost of Rs. 100 only. Nok 2,000 cubic ft. of records could be fumigated by *p*-dichlorobenzene in not less than 400 days with a minimum expense of Rs. 1,680. Thus we find that vacuum fumigation is about 40 times more efficient in speed but 17 times less costly. The advantages of *p*-dichlorobenzene fumigation are, at least in a tropical climate, more apparent than real. Vacuum fumigation is undoubtedly the ideal method of dealing with household moths and fungi on an extensive scale. A vacuum fumigation chamber 4½ ft. × 11 ft. × 5½ ft. (275 cubic feet) suitable for the fumigation of records can be obtained from the Guardite Corporation, 37, van Buren Street, Chicago, Illinois, at a cost of $3,600, *i.e.*, Rs. 13,000 (@ $1 = Rs. 3-3-0) including freight charges.

5. The question of vacuum fumigation has been widely discussed both in America and Europe. Happily there is no difference of opinion between American and English experts about the superior advantages of this method. Some details on the subject are given below :—

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(1) Weber, C. G., Shaw, M. B., and Back, E. A. " Effects of fumigants on Paper " National Bureau of Sandards Research Paper, R-P, 828. September, 1935.

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(i) The vacuum fumigation unit in the Huntington Library, California, has been in use since 1932 and has proved admirably effective (see T. M. Liams in the Library, Quarterly II, P. 375 : 1932).

(ii) The British Records Association (Technical Section, Bulletin 10, p. 4) says "The efficiency, speed and convenience of vacuum fumigation render it ideal for the treatment of archival material wherever a sufficient volume of work is available to justify the initial cost of installation."

(iii) Dr. Plenderleith (Research Laboratory, British Museum) is of opinion that "*The Vacuum fumigation process is doubtless the most effective method of dealing with book worm or any extensive scale*, and a gaseous mixture of ethylene oxide and carbondioxide has been demonstrated by Mr. Kimberly (National Archives, Washington, D. C.) and others to be a safe and satisfactory insecticide where archives are concerned."

(iv) The larger Scandinavian Museums, the Nordiska Museum, Stockholm and the National Museum, Copenhagen use vacuum fumigation in the treatment of textiles which resemble paper in many respects. This shows how much more care and vigilance is necessary in a tropical climate where various insects get a genial temperature and humidity and multiply prodigiously.

(v) Mr. Hilary Jenkinson, whom Dr. Baliga acknowledges as a leading authority on the subject, admits that insect pests are not so common in England and that in certain parts of the world the prevalence of the danger justifies special treatment. (See Archive Administration, 1937, pp. 219—21.)

(vi) "Libraries in England being generally free from book worms, the installation of expensive plants for fumigating books in this country is unwarranted. The process of vacuum fumigation is applied in the British Museum but only to ethnographical materials." (See British Record Association, Technical Section, Bulletin 11, pages 5-6, October 1940.)

6. Dr. Baliga has no objection to the adoption of the process of vacuum fumigation in the Record Offices in India except on the ground of cost. Fumigation by *p*-dichlorobenzene is, in his opinion, less costly but equally effective.

(a) The question of comparative cost has been fully dealt with in para. 4 *ante*. It will be seen that his statement is not borne out by facts. It may well be said that a vacuum fumigatorium will involve a greater capital expenditure, but this appears to be thoroughly justified in view of the substantial saving that will result in the recurring running expenses for fumigating the records. Well authenticated facts establish beyond doubt that fumigation other than by vacuum process is a false economy when a large quantity of records is to be tackled, particularly in a tropical country like India, where the moist heat is specially favourable to insect life.

7. The ordinary process of fumigation by paradichlorobenzene exposes the brittle documents to a risk of damage as the contents of the bundles will have to be spread out inside the chamber for the lethal gas to act on insects and borers. From an ordinary fumigation chamber of a large size, it is not possible to drive out speedily the absorbed and adsorbed gases with the result that unloading becomes delayed and difficult, if not unsafe, for the working crew.

8. Dr. Baliga seems to think that rebound and reconditioned volumes are practically immune to insect pests on account of the white arsenic in the Dextrine paste. Fumigation according to his way of thinking is of temporary urgency. But every page is not necessarily repaired when the volume is reconditioned

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and the poisoned paste therefore offers no protection to the volume as a whole. Insects on the other hand come from outside after the volumes and bundles have been fumigated and eggs unaffected by paradichlorobenzene are hatched in due course. Fumigation should, therefore, form part of the normal routine work of the record office. Arsenic moreover does not necessarily keep away insect pests for all time to come. Sometimes minute fungi ferment the paste and release volatile arsenic compounds. Such fungi not only affect adversely the durability of the paper but renders the paste absolutely harmless to the insect by removing the poison. I may mention in passing that the Dextrine paste has been in use in this department for the last 27 years and the formula will be found in our Staff manual. (See p. 31, 2nd Edition, 1922.).

9. From the facts and figures given above it is evident that the vacuum fumigation is cheaper and more effective than the fumigation by *p*-dichlorobenzene, suggested by Dr. Baliga.

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On a Sulph-Arsenical Insecticide, named ' Sulph-Arsenic ' and useful for preserving books from the ravages of insects.

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To a meeting of the joint session of different Scientific Societies held at Bangalore on the 20th March 1935 under the chairmanship of Dr. G. J. Fowler, I demonstrated the simple process of preparing the above Insecticide and talked out the possible uses of the same, particularly mentioning " Preservation of Books." There was an interesting discussion after the talk. Prof. V. Subramaniam of the Indian Institute of Science referred to the poisonous nature of Arsenic compounds and to the common practice of readers wetting the finger tip at the tongue when turning over the leaves of a book. Sastravaidyapravina Dr. S. Subba Rao remarked that, considering (1) in the present insecticide the Arsenic is coupled with Sulphur and (2) the quantity is small and put only between the cover and the fly leaf of the book, there is no sufficient room for any serious anxiety, provided it could serve the desired purpose of preserving the book. Fortunately, so far there has been no case of casuality amongst either the people who treated the books with this material or its readers. The first books that were treated have been under observation for the last over three years. They are still having the beneficial effect of the treatment which, it is hoped, may last for at least five years, when the treatment may again be repeated. Early this year, there was a report from one of the Sub-Registrars that his registers were very badly attacked by some insects and that immediate relief should be secured. At the suggestion of Dr. K. L. Moudgill those damaged registers were treated with the above insecticide. The attack has stopped and the Sub-Registrar seems to have been completely satisfied. The confining of the treatment of books with this solution to the part between the covers and the first leaf of the book is for the following reason : The small insects easily creep into the space between cover and first leaf and lay eggs ; the larvæ are developed. The larvæ are the most destructive. They begin attack in the direction both of cover and of the interior of the Book, in due time, drilling right through the book. Between two books, their hold is not secure and therefore they do not thrive. If the space between leaf and cover is made unwholesome by this treatment, the larvæ are not able to thrive and to commit the havoc.

As regards its application for palm-leaf manuscripts, I have not yet made any trial in this direction. But there is no reason why it should not be possible to sccure the same benefit with this treatment. For this purpose, the manuscripts are loosely packed in a shallow trough either of iron or copper sheet, enough of the book solution, after diluting it to an equal volume of water, is poured in just to cover the manuscripts. The manuscripts are left there for about an hour, then taken out and kept to dry for a day or two and put back in their original places. This process gives the leaf a wash with a weak alkaline liquid which would make it less liable to crumble and thus add to its keeping quality. The rack or the almirah in which the manuscripts are kept can also be painted with the same solution.

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The economic aspect of the treatment may be understood to be satisfactory from consideration of the cost of the two common commercial materials used in the preparation, *viz.*, (1) Arsenious Oxide, (2) Sodium sulphide. In normal times, Arsenious Oxide was selling at about Rs. 20 per cwt. and Sodium sulphide at Rs. 10 per cwt. 1 lb. of Arsenious Oxide with 1½ lb. of Sodium sulphide with enough of water to make 10 gallons of the book-solution or 20 gallons of the palm leaf manuscript solution, and costing about only 5 annas for the Chemicals used, would be sufficient to treat about 100 × 700, *i.e.*, 70,000 volumes of a medium size book or bound journal. The real cost is only that of the labour of treating with the material.

The author of the preparation has no ambition to reserve to himself the right of making it, and would be happy to leave it free to all book-lovers.

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